THROUGH-PROCESS OPTIMIZATION

OPEN DOORS TO NEW MARKETS WITH INTERCONNECTED OPERATIONAL EXCELLENCE

by

YUYOU ZHAI [1)]
WOLFGANG OBERAIGNER [2)]
KLAUS JAX [1)]

Abstract:

Through-Process Optimization (TPO) from Primetals Technologies is about integration of the know-how embedded Through Process Quality Control System (TPQC) and process domain knowledge of the entire steel production chain to enable steel plants for digital transformation for the highest performance. The centralized storage of high-resolution process data across the production route allows intelligent data analytics for process and product optimization and development of new steel grades within a short time. Know-how based rules support the operators for root cause analysis and quality decisions in time. Acting as a Lifecycle partner, TPO services will be provided based on topic selection and prioritization with customers to achieve their business objectives.

This paper describes the key TPQC features and TPO service concept as well as the key achievements on reference plants.

Keyword: Through-Process Optimization, TPO, Through Process Quality Control, TPQC, Lifecycle, interconnected operational excellence, tailormade, KPI, Process Optimization, Product Development, Data Mining, Know-How Rules, SPC

1) DT TPO department - Primetals Technologies Austria
2) EA TU TPQC department - Primetals Technologies Austria

THROUGH-PROCESS OPTIMIZATION(TPO)

Primetals Technologies has developed and introduced the Through-Process Optimization (TPO) solution, which targets the smart, digital interconnection of various process units and the accumulation of know-how along the entire steel-production chain.

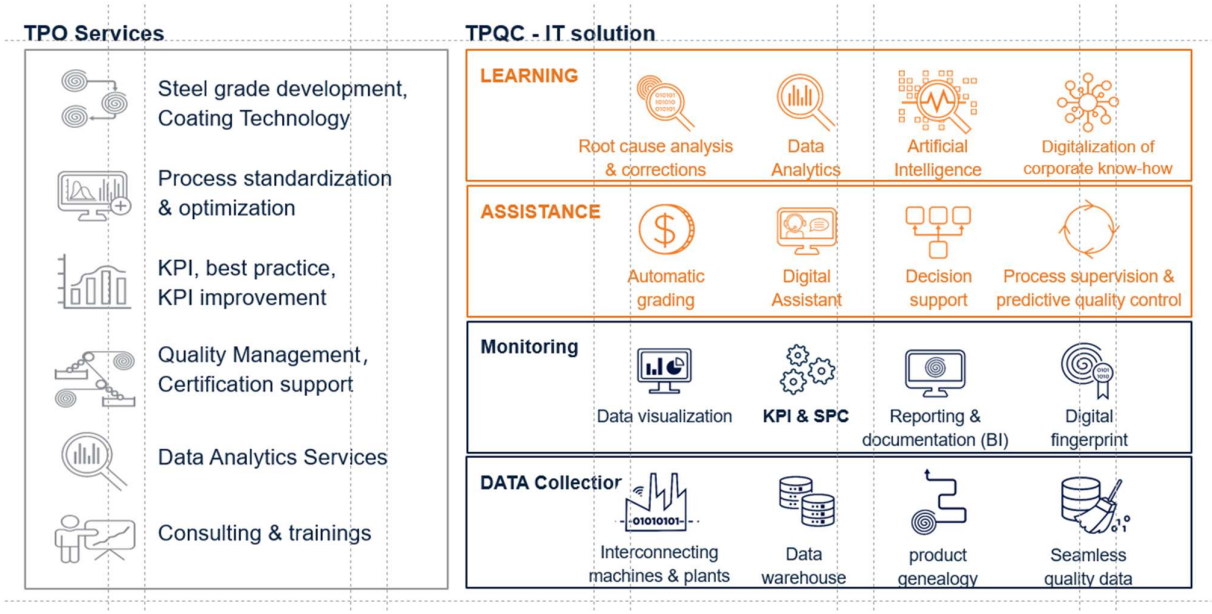


Figure 1: Overview of Through-Process Optimization(TPO)

With Through-Process Services we apply our comprehensive knowledge to improve the performance of our customers by advising them on product development and on producing new, high-strength steels, guiding the implementation and optimization of processes, providing support to KPI improvement, product certification, data analytics services and tailor-made consulting and trainings. The expert know-how will be made available as Expert Rules in our Through-Process Quality Control system (TPQC). TPQC is a know-how embedded monitoring and controlling of process and product quality across all production processes, to improve and speed up communication and information exchange between production units. Through the integration of data-based models, e.g. predictive and prescriptive models, the smart system is supporting operators and quality engineers with root-cause analysis and automatically generates recommendations for corrective and compensational actions. TPQC provides a powerful rules editor which allows digitalization of customer's know-how and make the best practice as standard for higher performance.

Through Process Quality Control (TPQC)

Think big, start small - The system is modular designed, flexible scalable in different dimensions, like coverage of production units, features and contents of services. The system can be tailored to meet customer's special needs.

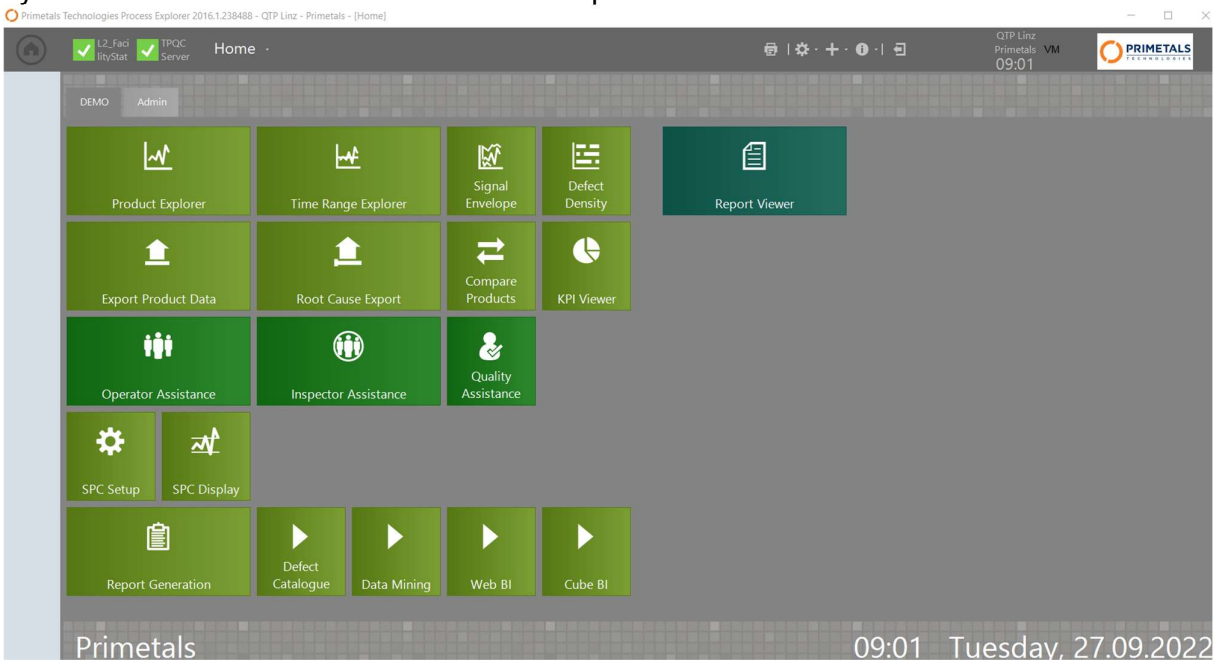


Figure 2: Through-Process Quality Control (TPQC)

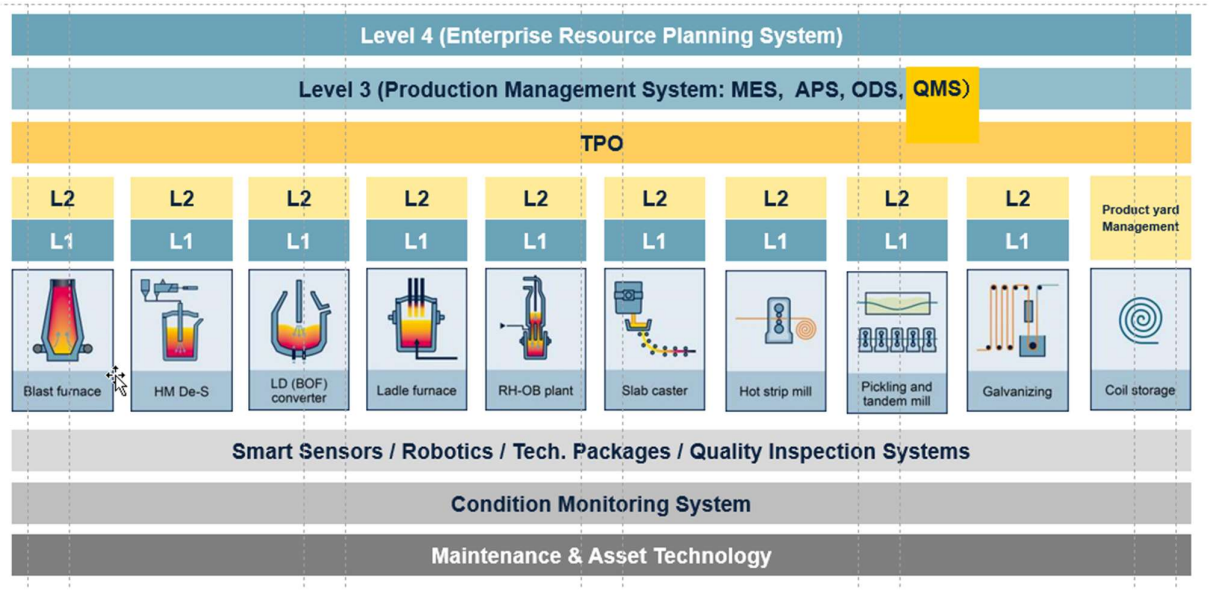


Figure 3: Integration of TPQC within Automation and IT System

TPQC collects all quality related, high-resolution equipment, process and quality data from L1, L2, L3, laboratory and surface inspections systems along the entire production chain,

data projection on length of intermediate and final products enabling full product genealogy. This enables a through process monitoring of all production steps, identifying possible deviations from the process and quality targets, root causes and suggestion of corrective measures on the actual production units or/and compensational measures on the next production units. The through-process data collection along the entire production process guarantees a solid base for quick quality analysis in case of possible client claims. Based on the process monitoring and product evaluation the system automatically performs product grading and release, and the integrated deviation management functions support authorized quality engineers and operators to handle the deviation and decision-making. The grading results can be communicated with L3 or L4.

Extensive built-in functions and Benefits:

- Through-process data collection and integration (process, equipment, quality)
- Tracking along the entire length of product, across all production units, including most high-resolution data.
- Automatic know-how-based rules for product grading and release
- Data based root cause analysis, corrective, and compensational actions
- Rules editor as platform for build-up customer own know-how, and digitalization of know-how
- KPI monitoring and improvement
- SPC: supervision of process capability, root cause analysis and action
- Prediction of the mechanical properties
- Prescriptive compensation for better quality and higher performance

Application of Data Analytics

Data is asset. Data analytics is about to find trends and draw conclusions about the information they contain.

A huge amount of data is generated during steel production. Once the data is collected, integrated and projected, the next step is to find and fix data quality problems that could affect the accuracy of analytics applications, like outliers, errors and duplicate entries.

Figure 4 shows the Data Analytics concept of Primetals Technologies which starts with statistics, reports and business intelligence (BI), followed by diagnostics and prediction of mechanical properties (Quality Guard) and virtual optimization (Quality Lab), and prescriptive optimization of key process parameters for better quality, which can help to increase revenue, improve operational efficiency and boost business performance.

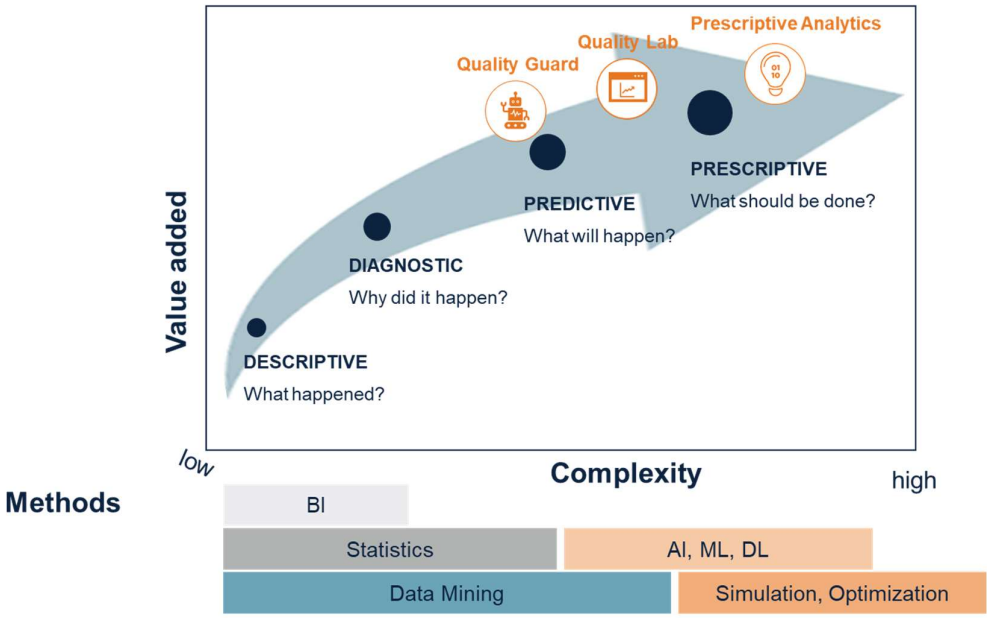


Figure 4: Data Analytics Concept of Primetals Technologies

The figure 5 shows the performance of the prediction of mechanical properties (Quality Guard). The results can meet standard for product release for most common steel grades. The prediction along the entire length of the coils in time ensure the right quality of the products to avoid claims, and quick reaction for operator in case of deviation between the predicted results and required properties to take necessary action to minimize quality deviation without waiting for test results. Reduced sampling and testing lead to higher yield and cost-savings.

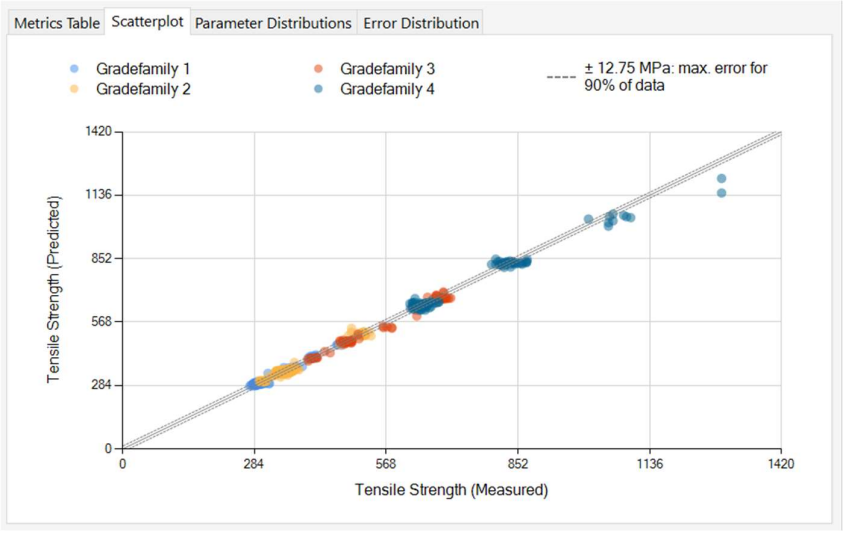


Figure 5: Comparison of measured and predicted values

TPO Services – Life Cycle Partnership

The key objectives of steel plants are to produce high added values products, to continuously improve the key performance indicators like output, yields and operational cost for sustainable business excellence.

As the worldwide recognized outstanding provider of advanced equipment and automation systems for steel production, Primetals Technologies is also a reliable lifecycle partner by offering Individual services. TPO (through process optimization) service is based on own comprehensive process and operational know-how that supports customers to enter new markets with new products to achieve their business objectives.

Acting as a Life-Cycle Partner for metals industry, Primetals Technologies has expertise, resources, and knowledge to provide flexible and tailor-made support to its customers.

Services approach:

- Tailored to customer demands and requirement
- Holistic approach horizontal up- and downstream
- Services for entire production chain
- Expertise in long term cooperation

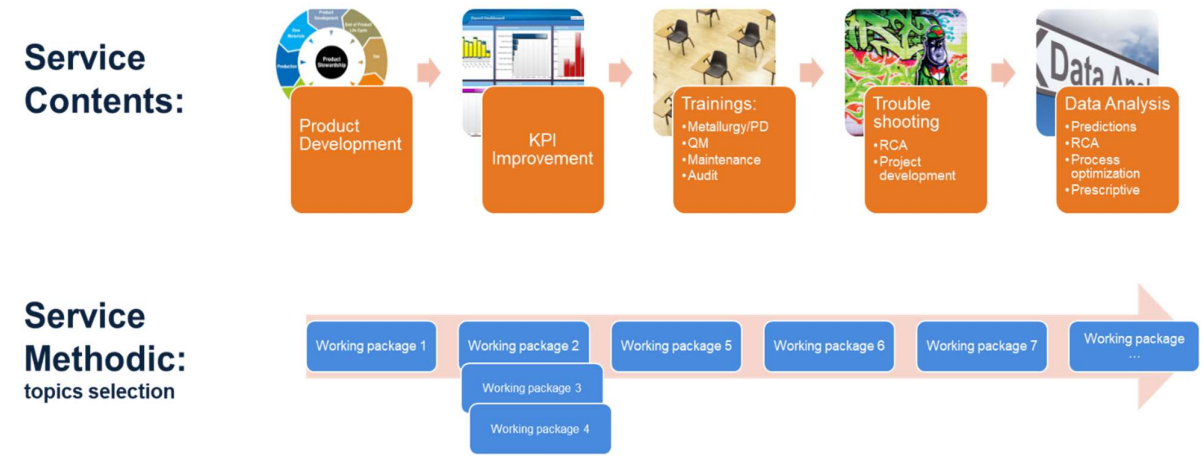
All services are provided based on in-house knowledge and competences.

Services are backed-up with

- Primetals international presence and network
- Expert pool
- In house technology database
- Proven simulation and evaluation tools
- Data analytics team

Support can be offered for following areas:

- Metallurgy and product development
- Quality management
- Production supervision and operation
- Technology development and upgrades
- Process automation, mechatronics and digital transformation (smart production)
- Various trainings
- Maintenance support
- Audit and consulting
- Data analysis and AI application



RCA: Root cause analysis

Figure 6: TPO Services Concept

Achievement at reference plants

In meanwhile there are many TPO references worldwide. The main achievements of the TPO project at Tangshan Iron & Steel Group Co Ltd, China (Tangsteel) will be highlighted more in detail.

To meet new market requirements and to ensure their leading position, Tangsteel decided to upgrade its production lines, encompassing hot metal treatment, steelmaking, casting, and hot rolling. The company also invested in a new cold rolling plant with PLTCM, CAL, and CGLs (CGL4, 5, 6) for production of IF grades up to advanced high-strength steels for the automotive and home appliances industries, as well as other high-end applications. Primetals Technologies was involved from the conception phase, collaborating on plant design, supply, erection, and commissioning of the project.

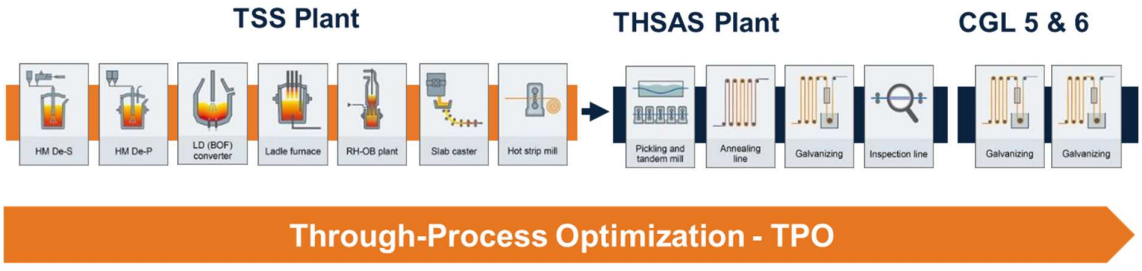


Figure 7: Tangsteel production chain: Steelmaking - continuous casting - hot rolling PLTCM - CAL/CGLs

TO ensure efficient product development, smooth ramp-up of the production lines, stable quality, and fast access to markets, Tangsteel awarded Primetals Technologies a know-how-based service contract for Through-Process Optimization (TPO). The main scope of the service contract included product development, quality management, training, KPI improvements, installation of the Through-Process Quality Control system (TPQC), and data mining for mechanical property prediction and more. During the project execution phase, different coating technologies were successfully developed and also applied to mass production, such as hot-dip aluminum-silicon coating (AS) and hot-dip zinc-magnesium coating (ZM). Now Tangsteel can supply high-quality products to domestic and internationally renowned OEMs in the automotive and home appliances industries.

Beside product development and successful application of different coating technologies for new market, the customer paid high attention to performance improvement regarding output, consumption, yield, quality and product certification. The know-how-based IT solution - Through-Process Quality Control System (TPQC) supports the entire processes, guides the actual productions and monitors the KPIs. The collection of all quality relevant data and the application of data analytics accelerated the development process significantly and acted as a powerful tool for further quality and performance improvements.

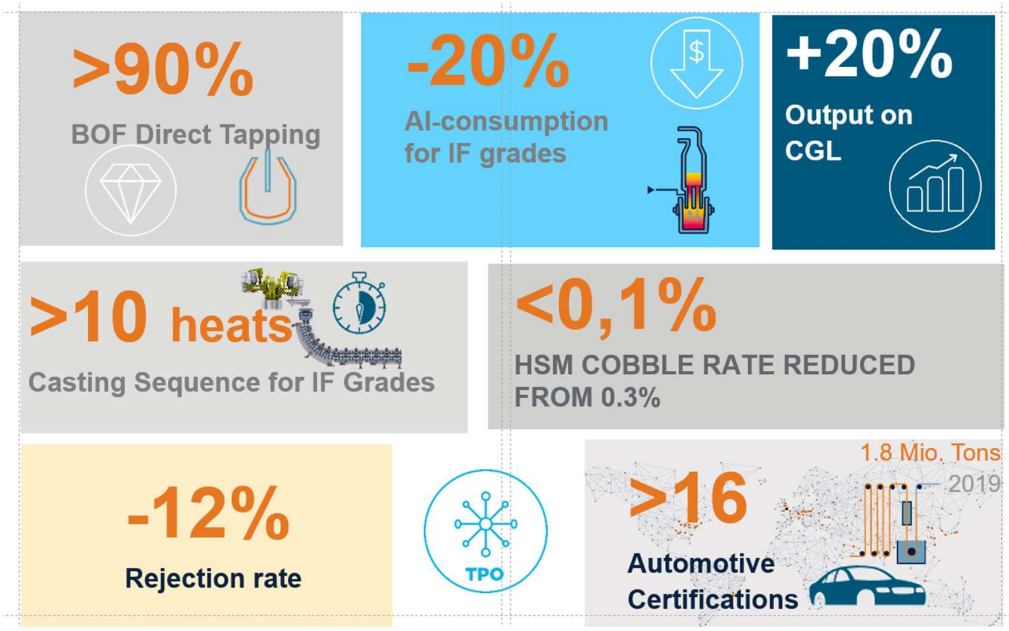


Figure 8: Key performance achievement (KPI)

The key performance achievement is highlighted in Figure 8. Now Tangsteel is in the leading position to provide steel products with the highest quality for automotive, home appliances and others.

Conclusion

The combination of process domain knowledge of the entire steel production chain, the know-how-based IT system - Through Process Quality Control System (TPQC), data analytics application and life cycle partnership service assists customers to achieve their business excellence in all aspects. Flexible and scalable approach eases implementation, to maximize the return of investment. Through-Process Optimization (TPO) from Primetals Technologies enables steel plants for digital transformation for the highest performance.

REFERENCES

1) Tan Wen Zhen; Xue Jun An; Pei Hong Jiang; Thomas Pfatschbacher; Yuyou Zhai; Klaus Jax; Wolfgang Oberaigner, Through-Process Optimization (TPO) - enabling Tangsteel to become a first class steel producer for the automotive industry and others, Steel Time International March 2021

2) Plaul, J. F., W. Oberaigner, Y. Zhai, T. Pfatschbacher, M. Kuegel, Through-Process Optimization (TPO), an integrated solution for steel production with best quality and highest productivity at lowest cost, 10th China International Steel Congress, 16-19 May 2018, Beijing/China

3) Bragin S., et. al. High strength steel production. A comparison of different production routes, 10th International Rolling Conference and the 7th European Rolling Conference, 6-9 June 2016, Graz/Austria

4) Arth, G., et. al. Experimental und numerical investigations on hot tearing during continuous casting of steel, 8th European Continuous Casting Conference, 23 - 26 June 2014, Graz/Austria